

This listing of claims replaces all prior versions, and listings, of claims in the application.

REMARKS

Reconsideration of the pending application is respectfully requested in view of the foregoing amendments and the following remarks.

Status of the Application

Claims 1-14 are currently pending. In this response, claims 1, 2 and 7 are amended. As support for the claims as amended is provided in the application as filed, e.g., page 4, no new matter has been introduced into the application by way of these amendments.

Summary of the Office Action

Claims 1-14 are rejected under 35 U.S.C. § 103(a) as obvious over EP 1 176 646 A1 (Graetzel et al.) in view of Van der Auweraer et al. (J. Phys. Chem. 1993, 97, 8808-11), with supporting evidence provided by Thelakkat (Macromol. Mater. Eng. 2002, 287, 442-61).

Claims 1, 3-8 and 10-14 are rejected under 35 U.S.C. § 103(a) as being obvious over Graetzel et al. in view of Shirota et al. (J. Mater. Chem., 2000, 10, 1-25), with supporting evidence provided by Thelakkat.

Discussion

Turning initially to the rejection of claims 1-14 over Graetzel et al. in view of Vander Auweraer et al., the former discloses the use of amorphous reversibly oxidizable organic compounds as hole conductors which may be doped with the anions thereof. However, this fails to motivate one skilled in the art to provide the invention as described in claims 1-7 which includes *inter alia* 1,3,5-tris-aminophenyl-benzene compounds in a stable cationic form; in fact Graetzel et al. teaches away from the claimed invention. Claims 1-7 are thus patentable on this basis alone.

With regard to claims 1-14, the amorphous reversibly oxidizable organic compounds disclosed in Graetzel et al. fulfill at least two functions: to efficiently receive holes from the sensitizing semiconductor and to efficiently transport the injected holes across the hole-transporting layer. However, Graetzel et al. fails to provide one skilled in the art with specific information that would enable one to identify suitable alternative amorphous reversibly oxidizable organic compounds to OMeTAD, and hence fails to provide motivation to investigate any particular class of hole conducting compounds in the absence of any indication of their efficacy in solid state photovoltaic devices. In the absence of such information, selecting particular hole transport compounds for use in solid state photovoltaic devices using the cited prior art is nothing more than guesswork.

In this regard, the asserted combination is not supportable, as Van der Auweraer et al. provides no teaching or suggestion that its compounds would be in any manner suitable for use in solid state photovoltaic devices. Absent any suggestion in this regard, the asserted combination rests impermissibly on hindsight. It is respectfully submitted that claims 1-14 are patentable.

Further, and assuming the combination was proper, the invention as claimed is not provided by this combination. Van der Auweraer et al. fails to disclose or motivate one to prepare 1,3,5-tris-aminophenyl-benzene compounds (as described in claims 1-14), let alone such compounds in a stable cationic form (as described in claims 1-7). The Office Action concedes that the compounds of Van der Auweraer et al. are non-ionized, and hence cannot inherently provide cations of such compounds. Thus, there is inadequate foundation for the assertion that the claimed subject matter, including 1,3,5-tris-aminophenyl-benzene compounds in a stable cationic form, is inherently present in this reference. This claimed subject matter is different than cation radicals—the latter which exist only during hole transport upon application of an electrical field.

A 1,3,5-tris-aminophenyl-benzene compound in stable cationic form means that non-ionized 1,3,5-tris-aminophenyl-benzene compounds have been converted into stable positively-charged 1,3,5-tris-aminophenyl-benzene compounds as indicated by changed absorption properties. In the examples, 1,3,5-tris-aminophenyl-benzene compounds were oxidized with $N(p-C_6H_4Br)_3SbCl_6$, with sufficient $N(p-C_6H_4Br)_3SbCl_6$ being present to ensure that the oxidation went to completion to the respective trications as determined spectrophotometrically. See page 23, lines 13-28, of the application as filed

Moreover, in the event of hole transport, one skilled in the art would expect the 1,3,5-tris-aminophenyl-benzene compounds disclosed in Van der Auweraer et al. to present very different transport properties relative to positively charged 1,3,5-tris-aminophenyl-benzene compounds. Indeed, while hole transport is reported for neutral 1,3,5-tris-aminophenyl-benzene compounds, there is no expectation from the prior art that one skilled in the art would expect the cationic form of 1,3,5-tris-aminophenyl-benzene compounds to exhibit hole transport. On the contrary, the cationic species would be expected to inhibit hole transport due to repulsion between the holes and the positively charged species, given that like charges repel one another.

As described in the application, it was surprisingly discovered that 1,3,5-tris-aminophenyl-benzene compounds exhibit relatively stronger photovoltaic effects relative to uncharged 1,3,5-tris-aminophenyl-benzene compounds. See, e.g., pages 4-5 of the application. As discussed above, this is counterintuitive to what one skilled in the art would expect. Applicants thus respectfully submit that claims 1-14, and claims 1-7 thereof, are patentable over the prior art of record.

Turning to the rejection of claims 1, 3-8 and 10-14, it is respectfully submitted that this rejection, premised on the combination of Gretzel et al., Shirota and Thelakkat, also is misplaced. Shirota discloses the results of using several classes of photo- and electro-active organic materials including amorphous molecular materials, titanyl phthalocyanine, oligothiophenes with well-defined structures, and non-conjugated polymers containing pendant oligothiophenes or other pi-electron systems. However, there is no specific teaching in Shirota that would motivate one skilled in the art to use a 1,3,5-tris-aminophenyl-benzene compound, let alone such compounds in a stable cationic form, in photovoltaic devices in the manner required by the aforesaid claims. To argue otherwise in the absence of any teaching would require the (impermissible) use of hindsight. Claims 1, 3-8 and 10-14 are thus patentable on this basis alone.

Further, even assuming *arguendo* the references were properly combinable, Shirota fails to disclose 1,3,5-tris-aminophenyl-benzene compounds in a stable cationic form (as described in claims 1-7). Shirota discloses and teaches only the use of non-ionized compounds, and hence cannot disclose, even inherently, the claimed subject matter which includes, *inter alia*, the aforesaid cations.

A 1,3,5-tris-aminophenyl-benzene compound in stable cationic form means that non-ionized 1,3,5-tris-aminophenyl-benzene compounds have been converted into stable positively-charged 1,3,5-tris-aminophenyl-benzene compounds as indicated by changed absorption properties. In the examples, 1,3,5-tris-aminophenyl-benzene compounds were oxidized with N(p-C₆H₄Br)₃SbCl₆, with sufficient N(p-C₆H₄Br)₃SbCl₆ being present to ensure that the oxidation went to completion to the respective trications as determined spectrophotometrically. See page 23, lines 13-28, of the application as filed.

Moreover, in the event of hole transport, one skilled in the art would expect the 1,3,5-tris-aminophenyl-benzene compounds disclosed in Shirota to present very different transport properties relative to positively charged 1,3,5-tris-aminophenyl-benzene compounds. Indeed,

while hole transport is reported for neutral 1,3,5-tris-aminophenyl-benzene compounds, there is no expectation from the prior art that one skilled in the art would expect the cationic form of 1,3,5-tris-aminophenyl-benzene compounds to exhibit hole transport. On the contrary, the cationic species would be expected to inhibit hole transport due to repulsion between the holes and the positively charged species, given that like charges repel one another.

As described in the application, it was surprisingly discovered that 1,3,5-tris-aminophenyl-benzene compounds exhibit relatively stronger photovoltaic effects relative to uncharged 1,3,5-tris-aminophenyl-benzene compounds. See, e.g., pages 4-5 of the application. As discussed above, this is counterintuitive to what one skilled in the art would expect.

Applicants thus submit that the inventions of claims 1, 3-8 and 10-14 are patentable over the combination of prior art asserted in the Office Action.

Conclusion

As Applicants believe the application is in proper condition for allowance, the examiner is respectfully requested to pass the application to issue. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,

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